



Trailblazer

Flight Projects Directorate Highlights

*Langley takes flight
blazing new trails for science.*

STMD

ARNMD

HEOMD

SMD

Feb - Apr 2016

Kick-starting the next generation of
climate observations / MEDLI2 testing
a step in making planetary exploration
more accessible and affordable /
Teamwork, quick thinking keeps
CERES FM6 on track for success

Introduction

A Message from the FPD Director



FPD's mission is to "organize and lead successful flight projects and to foster technical excellence for Langley flight project management." Because of the hard work and dedication of our team, we are doing just that for a variety of projects supporting Aeronautics Research, Space Technology, Science, Space Operations, and Human Exploration. We are fulfilling our goals and seeing our vision through to fruition. Others seek our project professionals to work on their own teams and other teams are adopting our project processes. Through FPD, Langley is engaged from concept definition to successful completion of flight projects. FPD is a trail-blazing organization contributing to challenging projects and working on many technological firsts. Some of our most recent successes include delivering SAGE III to KSC, TEMPO completing Critical Design Review, RBI completing Preliminary Design Review, LAS/Orion CDR, AA-2 SLC 46 platforms CDR, and MEDLI-2 conducting ballistic range testing, and those are just a few. We are doing great work and we want to find new ways to communicate those successes as well as promote and foster positive relationships, including this new FPD quarterly highlights publication. We hope you enjoy the first edition.

—Mary DiJoseph

Director, NASA Langley Flight Projects Directorate

Feb - Apr 2016 Highlights

MEDLI2 Completes Ballistic Range Testing	2
CLARREO Pathfinder on ISS Kicks Off	5
CERES FM6 Radiator Corrosion Resolution	7
Team Profiles: Bob Akamine and Lauren Bonine	9
Quarterly Image Contest and Annual Tagline Contest	12
Future Milestones	13

MEDLI2 Completes Ballistic Range Testing

The Mars Science Laboratory Entry, Descent and Landing Instrument 2 (MEDLI2) project completed a ballistic range test of the Mars 2020 aeroshell on April 6 in Aberdeen, Maryland. MEDLI2 is instrumenting the Mars 2020 aeroshell with pressure transducers and thermal sensors.

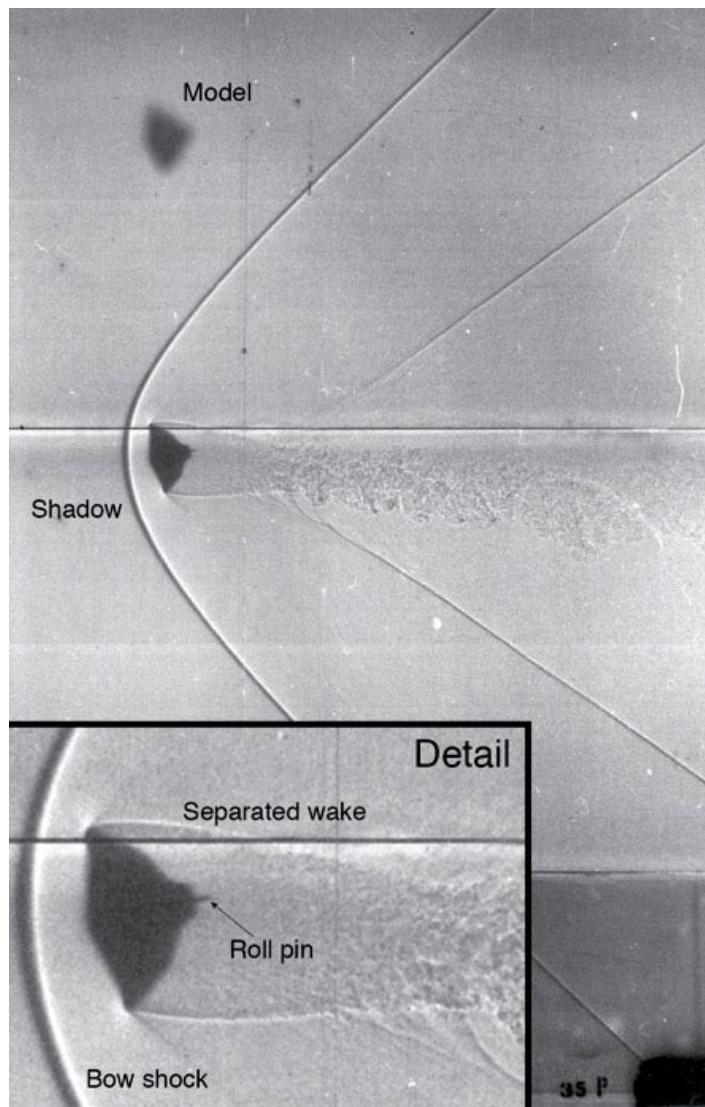
Pressure transducers produce an output signal proportional to the atmospheric pressure a vehicle is exposed to and thermal sensors detect changes in temperature on a spacecraft's surface during and through atmospheric entry. The ballistic range test was designed to provide flight-like data to inform selection of the type and location of backshell pressure transducer(s).

MEDLI2 transducers will be used to measure the backshell contribution to total drag of the entry vehicle. The measurements taken will provide data of great interest to NASA researchers studying atmospheric entry in order to make other planetary exploration safer with more reliable, lighter weight vehicles.

Mark Schoenenberger, MEDLI2's trajectory reconstruction lead at NASA's Langley Research Center in Hampton, Va., led the design of the model and test matrix. The models were small, only 90 mm in diameter, each with a mass of 1.4 kg and each instrumented with up to four pressure transducers. The test successfully collected aft body pressures as well as stagnation pressure to anchor the free flight Mach number during each shot.

"These are the first models of a blunt entry vehicle to be tested with onboard instrumentation and flown through a ballistic range," Schoenenberger says. "The success of these shots has yielded important data that will improve computational fluid dynamics (CFD) codes and hopefully inspire additional tests to explore many unanswered questions in the field of unsteady aerodynamics."

The models were launched from a 120 mm artillery gun at an initial Mach number of 3.0 at the Test and Evaluation Facility, a 200-m long indoor ballistic range at the Aberdeen Proving Ground, United States Army Research Laboratory (USARL). In addition to conducting the shots, the USARL designed the onboard instrumentation system and built and calibrated the models.



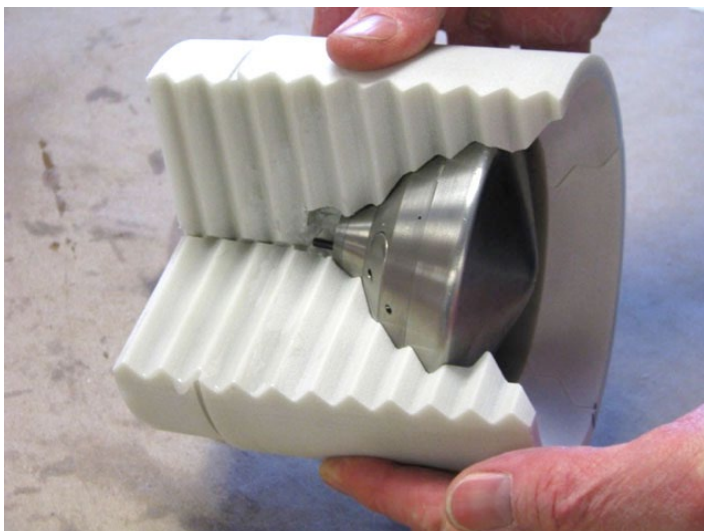
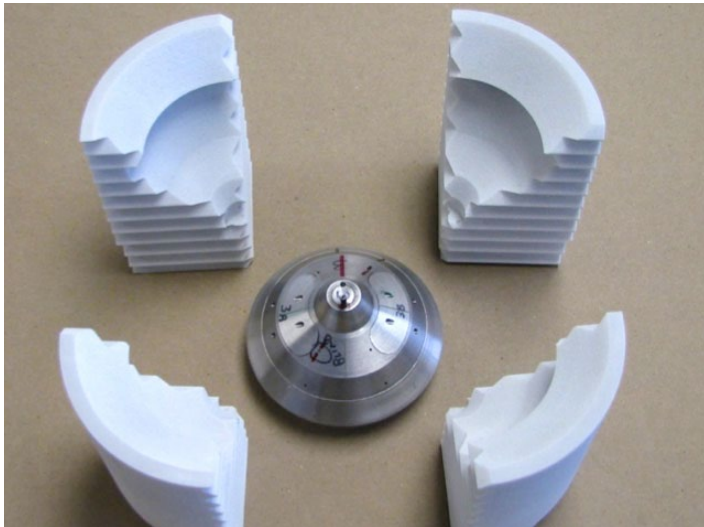
Pictured in this shadowgraph are the flow feature details captured during MEDLI2's ballistic range test. The roll pin helps indicate orientation of the blunt entry vehicle model during the shot.

But, ballistic range testing can present its challenges. There were some data recording problems; however, data were successfully collected from three shots and the minimum success requirements were met.

MEDLI2 Completes Ballistic Range Testing *(cont.)*

“A strange phenomenon was encountered during testing where the models stopped recording data mid-flight, a problem that had not been seen in testing before,” explains Schoenenberger. “It is suspected that the models were seeing a voltage from a “break screen” as they entered the ballistic range.

The break screen is commonly used during testing to provide a “time stamp” to correlate the timeline measured in the range with the onboard data. It is a piece of paper with a metallic ink circuit printed on it. As the model flies through the paper, it breaks the circuit, providing the time stamp.



Models are prepared in the sabot for the ballistic range testing.

“The USARL engineers have not been able to reproduce the failure with a similar setup in their lab yet, so it is pretty puzzling,” said Schoenenberger. “Fortunately, several shots recorded good pressure data prior to entry into the range. One of the shots recorded pressure into the range as well.”

Inside the range, 15 shadowgraph image pairs are taken of the model as it flies. From those images the model position and orientation is determined as it flies down the range. A trajectory is fit through the data to determine the velocity and angles of attack as well as sideslip versus time.

“Most important, it was determined that these data can be extrapolated upstream to provide the trajectory of the model while it was flying outside the range,” says Schoenenberger. “The first look at our best data set shows that we achieved our minimum success. That means we have a full set of onboard pressure data correlated with velocity and attitude information. The pressure data looks very clean and there are very interesting variations as the capsule oscillates, or pitches up and down, in flight.”

But again, ballistic range testing is a tricky business.

MEDLI2 ballistic range testing is a step in making planetary exploration more accessible and affordable.

“It is hard to catch the models at all,” explains Schoenenberger. “A lot of testing before the final series of shots was required to figure out how to reliably catch the models, using boxes filled with bundled cardboard boxes. A large number of measurements of the model shape and mass distribution were required to ensure the models would fly straight and not swerve away from the catcher boxes.”

All the pretest work paid off, though, and resulted in a great set of shots where every model was recovered.

Believed to be a first since the Viking landings, the test collected free-flight wake pressures on a blunt entry vehicle configuration at dormant supersonic conditions. These data were collected at sufficient rates to measure dynamic variations of the wake pressure as well.

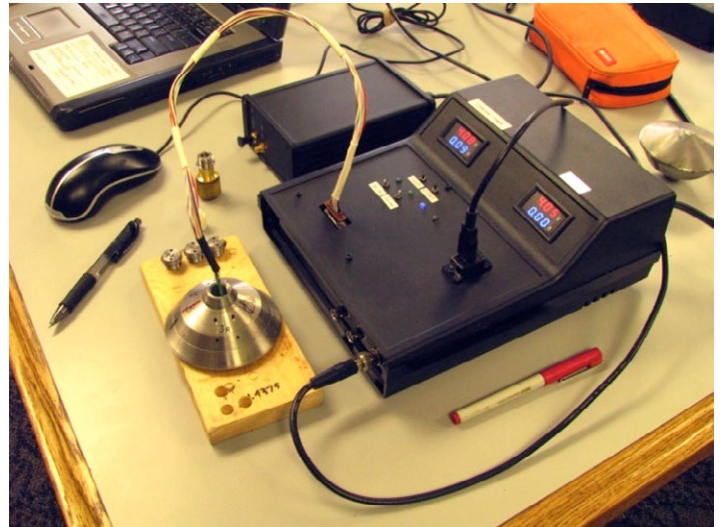
Schoenenberger says these data can anchor CFD analysis of wake flows that will improve our understanding of the

MEDLI2 Completes Ballistic Range Testing *(cont.)*

flow physics of separated wakes and improve computational models. At supersonic speeds the wake pressure on a blunt body accounts for a significant portion of the total drag. State-of-the-art computational tools still have problems predicting that contribution.

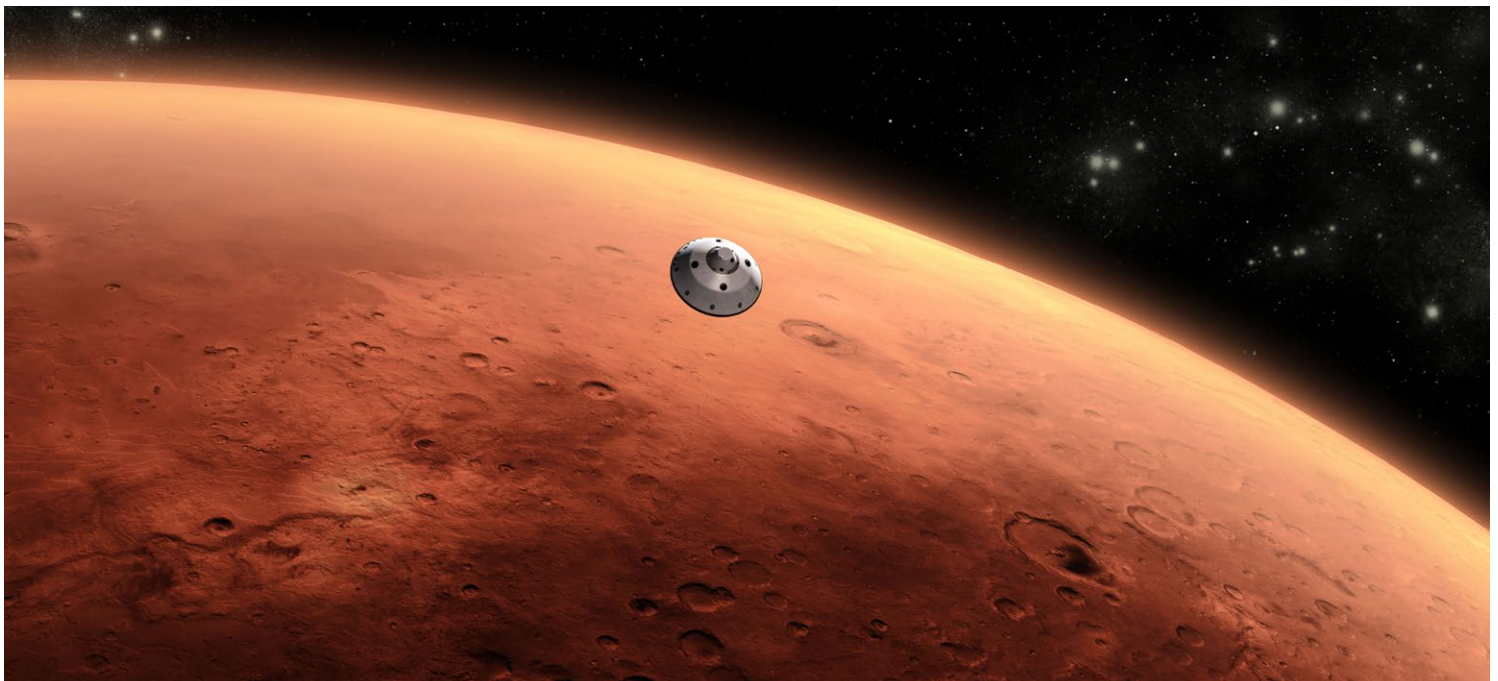
“Obtaining free-flight pressure data at known conditions is an important achievement and will help immensely in validating computational models,” he says. “Moreover, measuring the pressure as it varies with time can help determine the physics that drive dynamic instabilities of blunt bodies as well. At supersonic speeds, blunt bodies can start a self-induced wobble that can cause the model to tumble in severe cases. Understanding how the wake flow drives these flows is one of the great remaining challenges of supersonic aerodynamics.”

Testing was funded by the NASA Engineering and Safety Center (NESC) at the request of the MEDLI2 project. This data will help with the MEDLI2 backshell port selection and can serve to validate unsteady CFD predictions, some of which are planned as part of this NESC activity.



Equipment is set up to conduct mass properties evaluation.

The ballistic range data show the test technique can help unlock mysteries of unsteady wake flows. Better predictions of drag will enable future missions to land within smaller landing footprints. Better predictions of dynamic instability could help design future entry capsules that remain at small angles of attack throughout entry.



Above is an artist's rendering of the Mars Science Laboratory descending toward Mars. MEDLI2 is helping to prepare for NASA's journey to Mars.

CLARREO Pathfinder on ISS

Kick-Starting the Next Generation of Climate Observations

Climate change has never been easy to study, and it's mostly because Earth is a complicated planet. Naturally occurring changes in Earth's climate system—which involves intricate land, ocean and atmospheric dynamics—can confuse climate change observations.

To understand these changes, researchers juggle with numerous phenomena in their studies, like the role of clouds in cooling and warming the planet, temperatures and currents in deep oceans, and the way in which all living and nonliving things exchange molecules like oxygen and carbon dioxide.

Observations from hundreds of Earth-observing satellites have provided powerful insights regarding climate change. To improve those observations, NASA's Langley Research Center in Hampton, Va., is developing systems and technology to provide more accurate measurements of climate change and its consequences for the planet.

Langley researchers Bruce Wielicki, Patrick Taylor and Gary Fleming are working on a mission to launch a first-ever climate observing set of instruments to the International Space

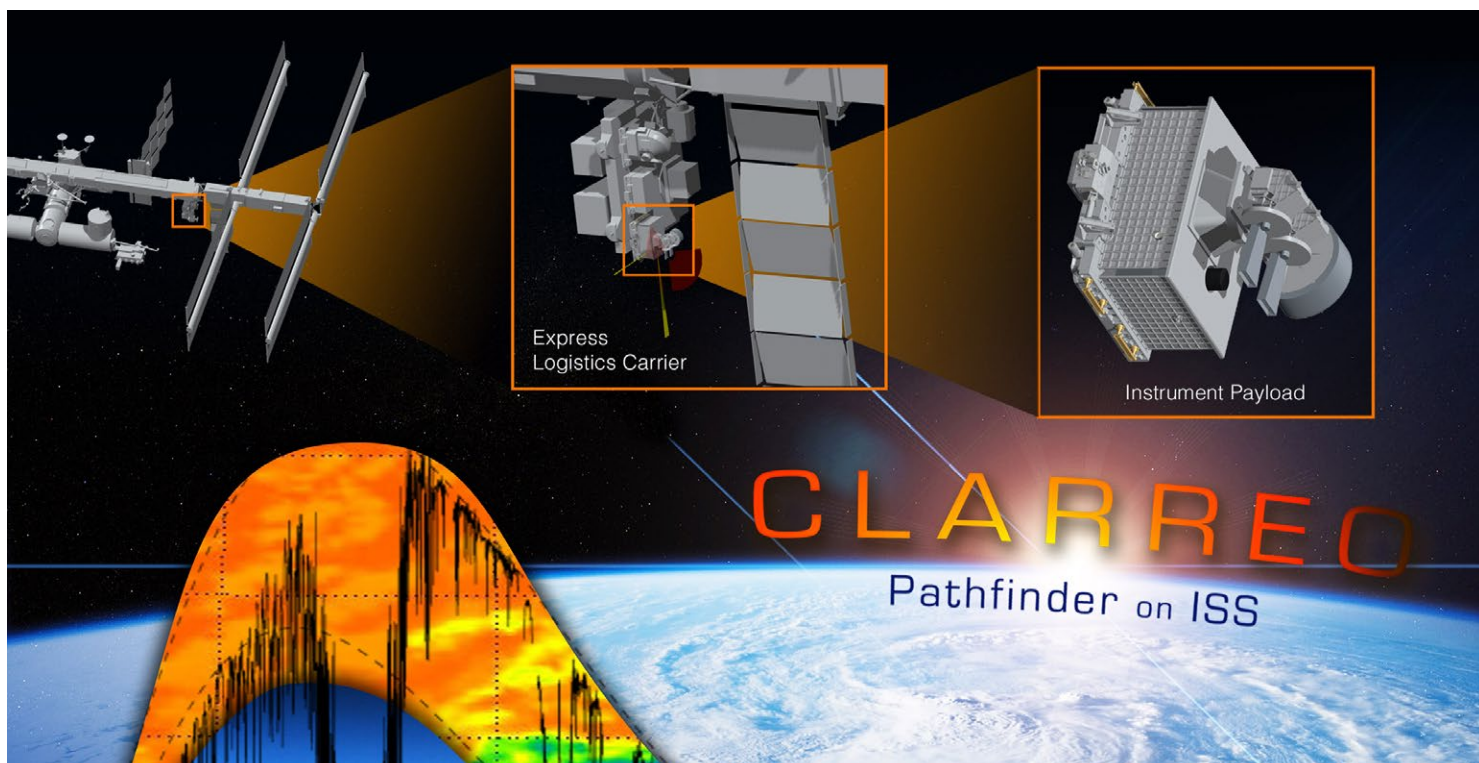
Station. Known as the Climate Absolute Radiance & Refractivity Observatory Pathfinder, or CLARREO Pathfinder, the mission will detect climate change signals with unprecedented accuracy.

"It will allow us to get the best evidence that we've ever had to show how fast the climate is changing," Taylor said.

After more than 5 years, Langley was given the green light to move forward with CLARREO Pathfinder, the next generation of climate observations.

On April 11, 2016, LaRC received authorization from NASA Headquarters – Science Mission Directorate, Earth Sciences Division to proceed with building a team and moving forward with the project.

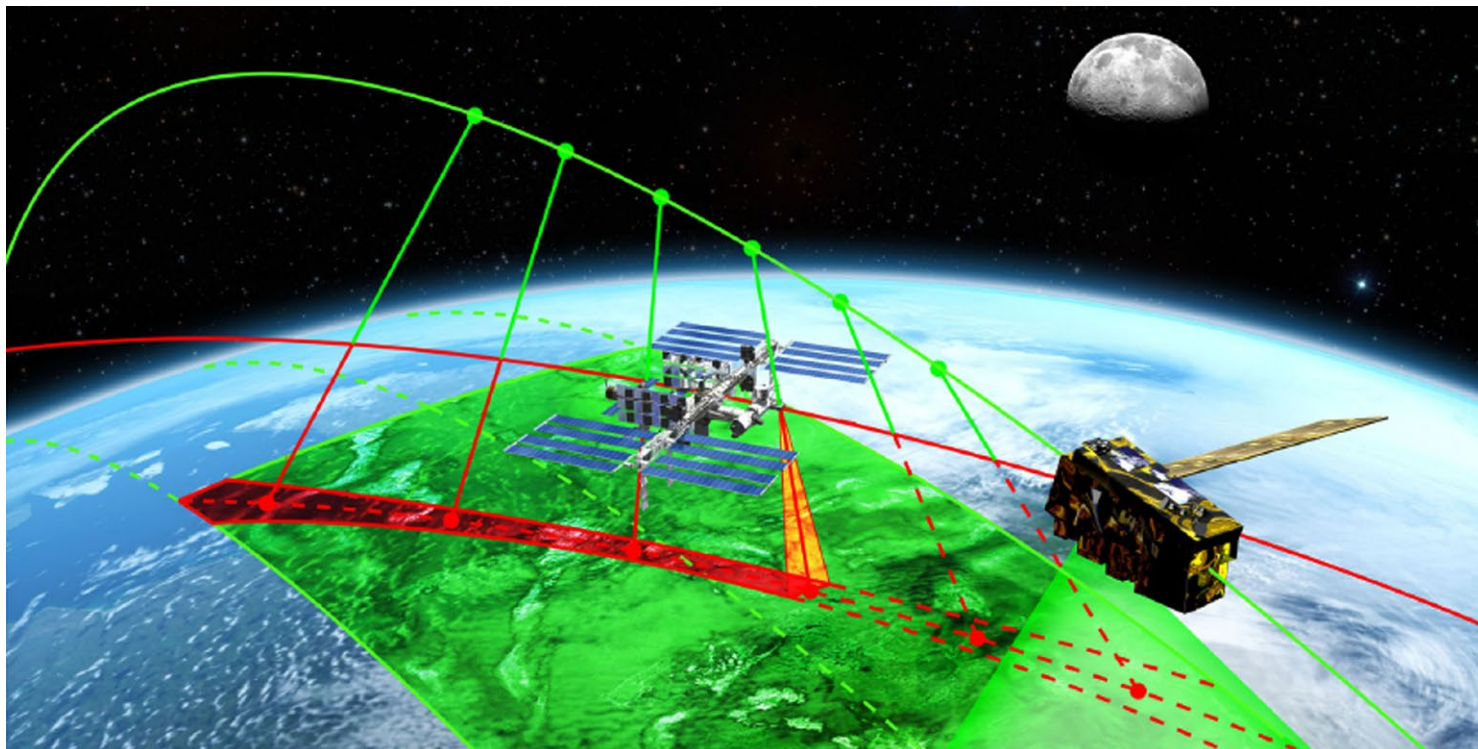
Expected to function for at least 1 year aboard the space station, the Pathfinder will demonstrate the technology to be



This artist's rendering shows where the CLARREO Pathfinder will be attached to the outside of the International Space Station.

CLARREO Pathfinder on ISS

Kick-Starting the Next Generation of Climate Observations *(cont.)*



An artist's rendering shows CLARREO Pathfinder on ISS RS inter-calibration.

used on a full CLARREO mission that could improve climate change research 15 to 20 years earlier than current satellites. It will be one of the earliest steps in designing a long overdue climate observing system, according to Fleming.

"A new paradigm in climate observation with a mission design very different from anything NASA has ever done," Taylor said.

CLARREO Pathfinder is designed to study the extremely subtle signals of climate change that most Earth-observing satellites aren't built to detect. These signals include variations in Earth's temperatures that occur over decades and at levels as subtle as a tenth of a degree. Weather satellites, for example, measure temperatures quickly to deliver the weekly, daily and hourly forecasts people use every day.

Thanks to its accuracy, CLARREO also will be able to verify measurements from other satellites on orbit are as accurate as possible. "We will be improving the quality of most other instruments that are in the current Earth observing system, so it's a pretty good return on investment for the cost of this mission," Fleming said.

CLARREO may also help reduce government and community expenses related to the consequences of climate change, like sea level rise, said Wielicki, who has paired with economists to study the potential implications of improving current climate change observations. For coastal areas that are sinking, like Hampton Roads, Va., the problem of sea level rise is very real.

Wielicki, Taylor and Fleming hope the CLARREO Pathfinder leads to the full CLARREO mission that will serve as a cornerstone for a full climate observing system. They plan to launch the Pathfinder in 2020. "Even though it's a pathfinder, this mission stands to make a real impact on what we can do to detect climate change and advance climate science, not just for us but for the global community," Fleming said.

Recommended in 2007 by the National Research Council as a top priority mission, CLARREO has been a joint collaboration with Langley leading multiple U.S. agencies, NASA centers, and both U.S. and international universities.

To learn more about CLARREO Pathfinder, visit:
<http://clarreo.larc.nasa.gov/about-pathfinder.html>

CERES FM6 Team Resolves Radiator Corrosion Issue

CERES FM6, next in the line of successful Clouds and the Earth's Radiant Energy System instruments, is installed on board the Joint Polar Satellite System-1 (JPSS-1) spacecraft at Ball Aerospace & Technologies Corp. (BATC), waiting for launch in 2017. The mission was a little more than a month away from heading into a rigorous environmental test campaign when team members discovered a problem.

On January 27, 2016, the team was conducting a thorough investigation of the optics due to suspect contamination when yellow staining, later found to be caused by corrosion, was discovered on the thermal radiators under the silver-Teflon® tape.

"One of the reasons that he [Carl Maag, contamination control engineer] found it, was he was using a new 385 nm LED light," said Chip Holloway, integration and test manager, who was at BATC when the problem was discovered. "Using other standard inspection lights, it did not show up."

Left as it was, there was a chance the instrument would be unable to reject the required amount of heat once on-orbit, which could negatively impact the mission success. The team snapped to action to make sure this instrument would be able to take valuable science data for a long time.

"The team gathered to brainstorm, find the cause and how to fix it, and get a handle on the history of the components all in parallel," said Steve Hall, CERES FM6 deputy project manager.

The root cause of the corrosion on the radiators was ultimately determined to be silver-Teflon tape installed in the 1990s that was cleaned with a chlorine-based solvent.

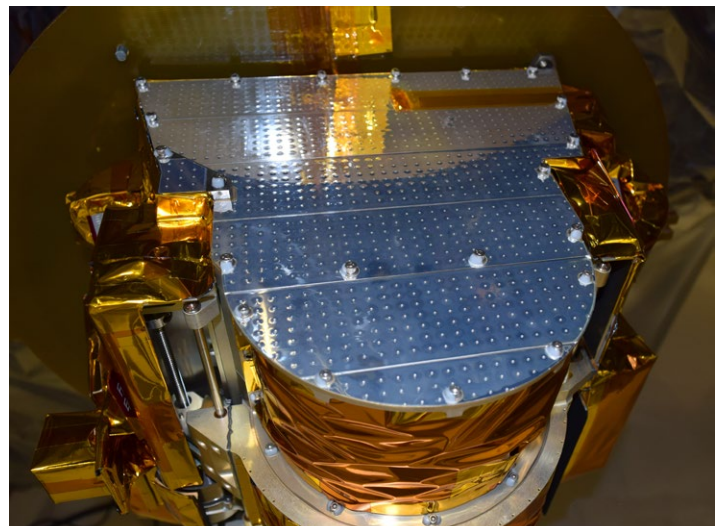
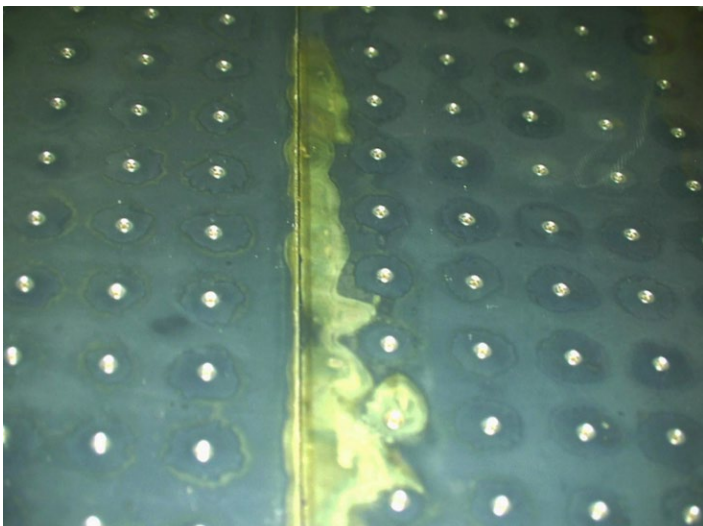
The team seemingly had three choices. They could leave everything as it was, scrape off the silver-Teflon tape and replace it, or they could replace the radiator panels. Chief Engineer Karen Gibson and the engineering team did some analysis of how each option would potentially impact the project.

Salvatore "Tory" Scola, lead thermal engineer, and his team conducted analyses to predict potential impacts. The thermal analysis cases they ran helped determine if the corrosion would impact solar absorption levels and if higher absorption levels would cause the instrument to run hotter.

Teamwork and quick thinking kept CERES FM6 on track for success.

"Then we wanted to go in and see if absorption was already degraded, so we wrote a procedure to test and all data came back within an acceptable range, so from a thermal perspective, it seemed like everything would be okay," Scola said.

There was one lingering uncertainty however. There was still a question about how the degradation would affect the radiators in the future, Scola added.



Above left panel corrosion can be seen; right are the new panels in place.

CERES FM6 Team Resolves Radiator Corrosion Issue *(cont.)*



Ron Hallet, Bruce Wolff, Karen Gibson, and Chip Holloway pictured at BATC before integration of the instrument on to the JPSS-1 spacecraft.

"Absorption always increases over time and we know how perfect radiators degrade over time, we just weren't sure if these would degrade faster or not, over time on orbit," Scola said.

Not wanting to take a chance on losing science data, or on contaminating the spacecraft by scraping the silver-Teflon off of the affected areas, eventually it was decided to replace the radiators.

Gibson worked out drawings and sent them to the fabrication department at Langley where new plates were built.

"Langley's fab shop and the technicians did an excellent job of the fabrication and application of the tape," she said.

In parallel, Scola and his team worked to get new silver-Teflon tape and write the procedures to put the tape on the new panels, to remove the old panels, and to install the new ones.

"It had to get done before environmental testing started because the testing is used to verify instrument operations and the vibration test is used to verify workmanship," Holloway

said. "So when we replaced the panels, we took a risk of not being able to vibrate the instrument, the last time to verify workmanship before spacecraft environmental testing."

The new panels were sent to BATC to bake out and the replacement procedures were successfully completed March 3. In just 5 weeks, the team identified a problem, was able to track down the history, troubleshoot and close in on a solution, build the replacements, and perform the swap.

"The team worked really well together, as soon as the problem was identified, we started discussing how to move forward," Scola said. "Everyone really stepped up."

Dynamics testing at the spacecraft level was successfully completed and the post-test inspection came back clear. The team is ready for electromagnetic interference/electromagnetic compatibility testing this month and thermal vacuum testing later this summer.

After the effort was completed, the old panels were brought to NASA's Langley Research Center, Hampton, Va., to be tested and the findings were the same as the team's predictions, ensuring the proper root cause had been identified.

"The mission is more secure based on the change," Hall said.



Langley team members work with the BATC team to integrate the instrument onto the spacecraft. Integration was conducted in December 2014 at BATC in Boulder, Colo.

Team Profiles

Bob Akamine



When Bob Akamine was little, building space shuttles with LEGOs, he dreamed of working at NASA one day. He loved to watch sci-fi shows and movies and think about how he could make those fantasy technologies a reality. In 2007 his goal was realized and he's been working on space-bound technology since.

"Working at Langley has been more than enjoyable, it has truly been a dream

come true," Akamine said.

Now, as the Lead Electrical Engineer for the Radiation Budget Instrument (RBI), Akamine leads a small team working to understand the electrical design of the instrument being built by Harris Corporation in Fort Wayne, Ind. Along with Harris, Akamine works with Orbital, the prime on the Joint Polar Satellite System 2 (JPSS-2) spacecraft on which RBI will fly.

The team is generating studies to ensure the design will meet the needs of the mission, providing assistance in reviewing documents, schematics and drawings, conducting field programmable gate array (FPGA) reviews, and supporting requirements managers, systems engineers, and life-cycle reviews.

As the RBI project moves forward and Harris prepares to build the engineering development and flight unit, Akamine's role will grow to include managing any non-conformance reports that may occur and providing technical subject matter expert (SME) opinion on the spaceflight instrument.

The position can be challenging at times, but Akamine is up to the task and welcomes the chance to tackle new technical and engineering challenges.

Akamine's training and education helped prepare him for his work. He entered the United States Air Force right out of high school and was trained as an electrical system technician to work on communication, radar, and electronic warfare systems. After leaving the military he went on to get his bachelor's degree in electrical engineering from Capitol College in Laurel, Md. From there an internship led to his first job as a contractor at NASA's Goddard Space Flight Center, Greenbelt, Md., in the Communications Standards and Test Lab. There he helped design an FPGA-based tracking and data relay satellite system transceiver that was flown on the CoNNeCT project.

Then in 2009, he was brought on at NASA's Langley Research Center, Hampton, Va., to work on his first job at Langley, STORM (Sensor Test for Orion Relative-Navigation Risk Mitigation). This work on a next-generation docking camera and navigation system was fast-paced, he said, a kind of trial by fire.

"But it couldn't have been more rewarding to work on a shuttle mission; STORM flew on Endeavour, the second-to-last shuttle to fly before the program was retired," said Akamine.



Bob Akamine is a big fan of playing an old Irish sport called Hurling and is even a certified referee.

Team Profiles

Bob Akamine (cont.)



Akamine's job on SAGE was to work on the project's electronic systems, especially the Interface Adapter Module.

Since STORM, Akamine has transitioned to a civil-servant position and has worked on the Stratospheric Aerosol and Gas Experiment (SAGE) III on the International Space Station project.

"My experience on SAGE helped me expand my FPGA expertise and gain understanding of the hardware path to flight," he said. "I started as an electrical engineer and ended as the Interface Adapter Module lead."

Outside work Akamine lives an active life with his wife and son. With nearly the pace and challenging intensity of working on a shuttle mission, Akamine and his wife are heavily involved with Hurling, a 3000-year-old Irish game resembling field hockey, lacrosse, and baseball. The pair plays in local hurling leagues, and Akamine—who is also a certified referee—travels to national competitions with the team he helps run.

Other Irish traditions he is fond of, though he's admittedly not of Irish descent, are whiskey and scotch tasting and cooking black and white puddings, dishes rarely seen in the United States. Black pudding is a type of blood sausage made from pork fat, pork blood and oats. White pudding is similar to black pudding, but does not include blood. A self-proclaimed foodie, Akamine does not limit his culinary adventures to Irish dishes; he will try anything and loves to sample and attempt new recipes from around the world.

Whether engaged in work or personal life activities, doing so with passion is important to Akamine and evident in the things he does every day: from delivering his expertise in technologies to help advance NASA missions to serving up a fine single malt alongside maybe a dish of black pudding scotch eggs.

Team Profiles

Lauren Bonine

As a Flight Projects risk manager, Lauren Bonine gets to remain safe here on Earth while working projects that will fly in space, and that suits her just fine.

"I've always been fascinated by flying, aviation, and human spaceflight," Bonine said. "Growing up I wanted to be an astronaut, but earning a Private Pilot Certificate I learned that I was more comfortable with my feet on the ground."

Bonine's background is in aviation. She attended Western Michigan University and studied Aviation Science and Administration. Her first job out of school was in airport/airfield operations at Teterboro Airport in New Jersey. She joined NASA's Langley Research Center in 2010.

As a risk manager for Ascent Abort 2 Flight Test Articles and Stratospheric Aerosol and Gas Experiment III on ISS, Bonine is responsible for leading the risk management process. The work entails performing risk analysis, developing and maintaining risk management documentation and reporting, and working with programmatic and technical project team members to identify and manage risk to project success.

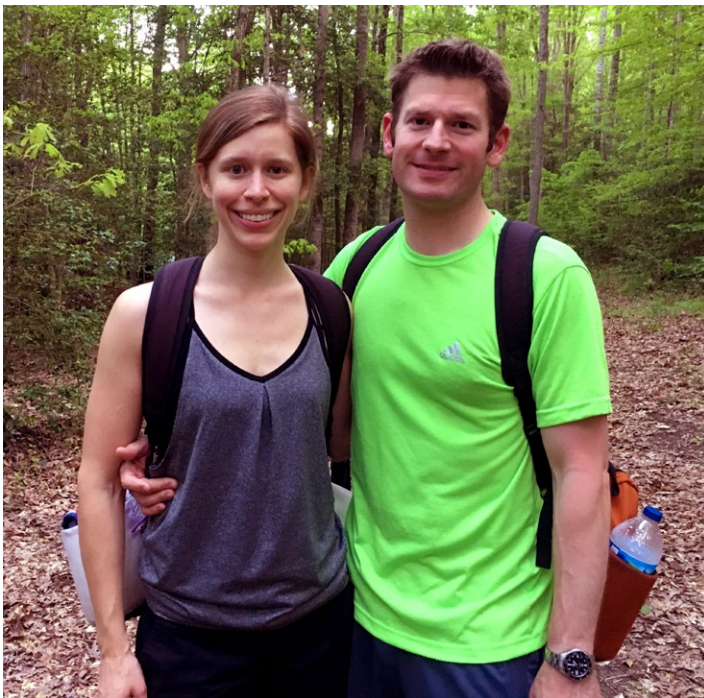
There are some nuances to facilitating discussions at the right level to get meaningful and useful information to support the risk management process.

"It can be challenging understanding the big picture across systems and disciplines that are highly technical," Bonine said, "But I really enjoy being a part of a team working on a common goal and seeing projects mature from formulation to flight."

Bonine also enjoys interesting hobbies outside of work.

"I enjoy playing disc golf," she said. "My husband and I play casually and competitively in local and regional disc golf events, leagues and tournaments."

Other than disc golf, Bonine enjoys catching up on favorite TV shows, cooking, and gardening, she even serves on her homeowner's association landscape committee. She and her husband also try to check out the local parks, museums and "touristy" spots as well as doing small projects around their home.



Lauren Bonine and her husband enjoy disc golfing and play on several leagues.



Lauren Bonine and Mike Cisewski, SAGE III project manager next to the SAGE III instrument.

Quarterly Contest

2016 First Quarter Image Contest Winners Announced



We had a great round of submissions for our first quarter image contest. Thanks to everyone who submitted a photo.

The image above of the SAGE III/ISS team is the winning submission. It features many, but not all, of the huge team it took to prepare the SAGE III/ISS instrument for space flight in front of the clean tent containing the payload.

George Homich, NASA Langley Research Center photographer, took the photo just a couple of days before the in-

strument was shipped to NASA's Kennedy Space Center, Cape Canaveral, Fla. Getting the instrument ready to leave Langley was the culmination of more than a year of team members working three shifts and weekends to integrate the payload and run a series of rigorous environmental tests.

This will be a regular quarterly contest so brush up on your photography skills and get creative with your image submissions for the next round.



Coming in second place is the photo of TEMPO team members with Administrator Charlie Bolden submitted by the TEMPO team. Learn more about TEMPO in the next quarterly.



Coming in third place is a graphic of QueSST submitted by Jonathan Behun. The Quiet Supersonic Technology, or QueSST, concept is in the preliminary design phase and on its way to being one of NASA's first X-planes.

2016 Annual Tagline Contest Winners Announced

In looking for new ways to communicate the great work being done in the Flight Projects Directorate, a good tagline that could sum up what it's all about seemed like an obvious component.

Because FPD is constantly changing and there is such a diverse breadth of research happening, we decided to invite input from the organization on an annual basis. We received some creative submissions and the contest winner will be featured on the cover of our annual report.

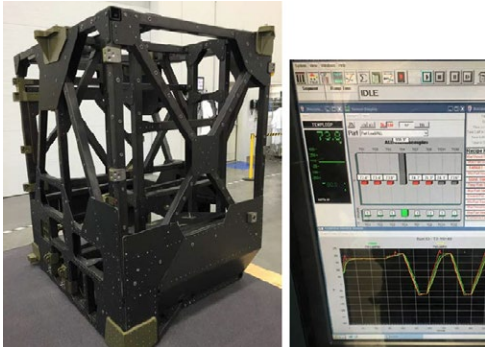
This year's winner is **"From Concept to Flight and Beyond,"** submitted by Kristyn Damadeo. FPD is involved in the entire process of building a flight mission and the tagline reflects that.

The two runners up are "Today's Challenges - Tomorrow's Successes," submitted by Dimitri Solga, and "Langley - Blazing Trails to New Heights," submitted by Doree Fitzhugh and Terrie Seitz.

Future FPD Milestones

Along the Way to Flight...

JUNE



TEMPO-Instrument

4th Annual Science Team Meeting: June 1-2, 2016

NASA's first Earth Venture Instrument will measure pollution of North America from Mexico City to the Canadian oil sands and from the Atlantic to the Pacific hourly and at high spatial resolution. The TEMPO (Tropospheric Emissions: Monitoring of Pollution) instrument is a UV-visible spectrometer and will be the first ever space-based instrument to monitor air pollutants hourly across the North American continent during daytime. It will collect high-resolution measurements of ozone, nitrogen dioxide and other pollutants—data that will revolutionize air quality forecasts. TEMPO observations are from the geostationary vantage point, flying on a telecommunications host spacecraft with the goal to launch in 2019.

JUNE



SAGE III / ISS

Operational Readiness Review: June 8, 2016

The SAGE (Stratospheric Aerosol and Gas Experiment) III instrument will launch later this year on SpaceX-10 to the International Space Station where it will monitor ozone and aerosol in the upper atmosphere. The SAGE III sensor assembly consists of pointing and imaging subsystems and a UV-visible spectrometer. The pointing and imaging systems are employed to acquire light from either the sun or moon by vertically scanning across them. These measurements are vital inputs to the global scientific community for improved understanding of climate, climate change, and human-induced ozone trends.

JULY



CERES FM6

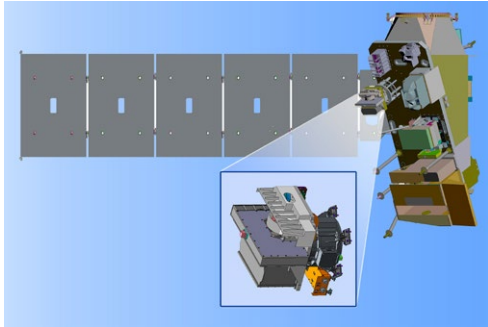
Thermal Vacuum Test: July 5-September 7, 2016

The CERES instrument is a three-channel radiometer whose products include both solar-reflected and Earth-emitted radiation from the top of the atmosphere to the Earth's surface. Cloud properties are determined using simultaneous measurements by other instruments such as the Moderate Resolution Imaging Spectroradiometer (MODIS) and the Visible Infrared Imaging Radiometric Suite (VIIRS). Analyses using CERES data build upon the foundation laid by previous missions, such as NASA Langley's Earth Radiation Budget Experiment (ERBE), and lead to a better understanding of the role of clouds and the energy cycle in global climate change.

Future FPD Milestones

Along the Way to Flight... (cont.)

JULY



RBI

RBI KDP-C: July 8, 2016

The Radiation Budget Instrument (RBI) is a scanning radiometer capable of measuring Earth's reflected sunlight and emitted thermal radiation. RBI will fly on the Joint Polar Satellite System 2 (JPSS-2) mission planned for launch in November 2021 and will extend the unique global climate measurements of the Earth's radiation budget provided by the Clouds and the Earth's Radiant Energy Systems (CERES) instruments since 1998.

JULY

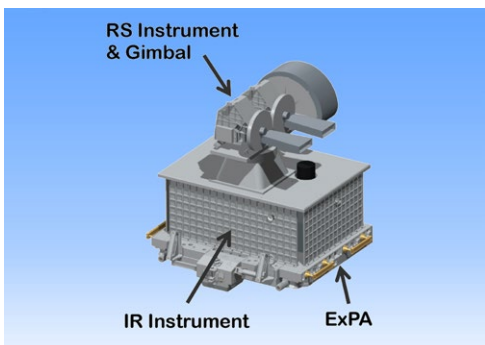


ARM

KDP-B: July 15, 2016

The Asteroid Redirect Mission will provide an initial demonstration of several spaceflight capabilities needed to send astronauts deeper into space, and eventually, to Mars. The agency plans to announce the specific asteroid selected for the mission no earlier than 2019, approximately a year before launching the robotic spacecraft. The robotic mission will visit a large near-Earth asteroid, collect a multi-ton boulder from its surface, and redirect it into a stable orbit around the moon. Once it's there, astronauts will explore it and return with samples in the 2020s. This Asteroid Redirect Mission (ARM) is part of NASA's plan to advance the new technologies and spaceflight experience needed for a human mission to the Martian system in the 2030s.

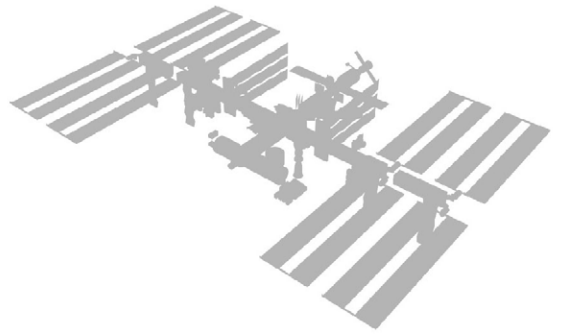
AUGUST



CLARREO Pathfinder

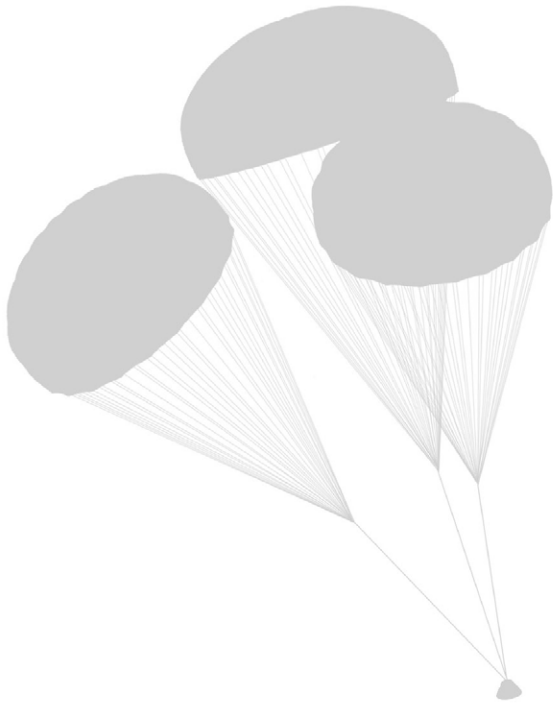
Mission Concept Review: August 24-25, 2016 (TBR)

The Climate Absolute Radiance and Refractivity Observatory (CLARREO) Pathfinder mission will demonstrate essential measurement technologies required for a full CLARREO mission. The reflected solar instrument will be hosted on the International Space Station (ISS) in the 2020 time frame. The foundation of CLARREO is the ability to produce highly accurate climate records to test climate projections in order to improve models and enable sound policy decisions.



*do not go
where
the path may lead,
go instead
where
there is no path
and leave a trail.*

—Ralph Waldo Emerson



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